International Fragmentation in the Presence of Alternative Health Sector Scenario : A Theoretical Analysis

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Abstract: This paper attempts to integrate among international fragmentation, trade liberalization and health sector. For this purpose we have considered two different models based on Heckscher-Ohlin-Samuelson general equilibrium structure, with special reference to the health sector. In the first model we have considered four sectors and we have assumed the production process of the health sector can be fragmented. In such a set up we have shown that a movement from a regime of no fragmentation to a regime of fragmentation may lead to an expansion of the health sector. In the second model we have considered three sectors and have assumed that production process of the health sector is fragmented. In that structure we have shown that trade liberalization leads to an increase in the output level of the health sector.

Key words: Health sector, Health Intermediate sector, International fragmentation and International health capital mobility.

JEL Classification: I10, F11

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1. Introduction

In recent years the importance of health sector as a potential engine of growth as well as for development for a developing economy like India has been argued by many contemporary economists. The health sector has shown a growth of 9.3 % between 2000-2009, comparable to the sectoral growth of other emerging economies such as China and Brazil[1]. The total value of the sector was more than $38 billion, about 5.1% of GDP (Ernst & Young: Fostering quality healthcare for all, 2008). Indian Healthcare market is estimated to touch US$ 77 billion by 2013(Pricewaterhouse Coopers, 2007). Healthcare industry accounted for 5.1% of India's GDP in 2006. The compound annual growth rate of Indian healthcare sector was 16% during the 1990s. (Pricewaterhouse Coopers, 2007) and is expected to grow at a compound annual growth rate (CAGR) of 15% over the next 15 years (Ernst & Young: Fostering quality healthcare for all, 2008). It is also expected to generate employment to 9 million people in 2012. (Ernst & Young: Fostering quality healthcare for all, 2008).

In recent past the recession in 2008 and recent economic slowdown since 2011 intensified by the Eurozone crisis and the slowdown in the US economy, have brought about a gloom in world economic growth projections. A recent report released by the United Nations (UN) shows that all developing economies will get affected by the slowdown. However, the good news is that East Asian and South Asian economies are increasingly being seen as growth drivers of the world as an outcome of which the health sector has grown exponentially. A CII- Mckinsey report states that the Indian health sector has emerged as one of the largest service sectors with estimated revenue of around $30 billion constituting 5% of GDP and offering employment to around 4 million people. By 2025, the Indian population will touch 1.4 billion with about 45% constituting urban adults[2]. To cater to this demographic change, the health sector will have to be about $100 billion in size contributing nearly 8-10% of the future GDP. The growth in the health service sector would be driven by health care facilities, medical diagnostic and pathological laboratories and medical equipment sector. All these growth inducing factors are related with Medical

[1] Source: Yes Bank and Assocham report, as quoted by IBEF report on Healthcare accessed on 30.01.2012.
[2] Source: The Times of India, dated: 02.02.2012.

equipment and devices. Medical equipment and devices industry is another sector that is very closely tied up with the health service sector. Actually health service sector uses medical equipment and devices as an intermediate product for the production purpose. Advancement and innovations in medical technology resulted huge improvement in this intermediate sector. In India, over 65% of the medical equipments are still being imported from abroad in a very fast growing domestic market and it was 80%- 90% in the pre liberalization period[3]. It is very often argued that developing countries like India, import medical equipments and other related devices for its health service. Such a health service sector can be considered as an exportable sector The medical equipments and devices market is worth US$ 1505 million in India and the demand is growing at about 15% per year.

It is to be noted that given the growing demand, the emergence of reputed private players and the huge investment needs in the healthcare sector, has resulted in growing interest among foreign players and non-resident Indians to enter the Indian healthcare market. The growing presence of corporate players and foreign investors in India's health sector, although highlighted and also documented in various reports by different sources, is not yet well understood in terms of its current status as well as its implications for the health system at large. For example, while the emergence of corporate hospitals or foreign funding and tie ups in the hospital segment can have many positive implications, such as helping to improve physical infrastructure, standards, quality of healthcare, technology, and processes along with spill over benefits in areas such as medical devices, pharmaceuticals, outsourcing, and research and development, it may also result in higher costs of health care and greater segmentation between the public and private health sectors. Thus, there is a need to examine whether there exists any constraint related to inflow of foreign capital in health sector. However, there are external and domestic factors, which constrain foreign investment, especially foreign direct investment (FDI hereafter) in India's hospital segment. One of the external factors, which has been noted is that, notwithstanding trends towards privatization in health in major developed countries, this is a sector that is undergoing reform and internal problems in those economies. In many countries, the number of private players who can establish hospitals overseas is limited. Hence, the potential number of overseas institutions that can invest in emerging markets may be rather limited. Again, for some

[3] This implies health service sector is internationally fragmented.

countries it is primarily domestic factors that are specific to the hospital business that are responsible for limiting the extent of FDI in India's hospitals. These include initial establishment related factors as well as post-establishment related operational issues, which affect the returns to investment. To remove these problems state have taken some steps in a post globalization period and they are

1) reduction of import duty for medical equipments and devices to 5% with countervailing duty (CVD) 0f 4%, over 50% of which are being imported. Assistive devices, rehabilitation aids, etc. have been completely exempted from CVD (Union Budget 2010-2011),

2) relaxed rules for the NRI medical practitioners to invest and provide medical services in India (Baru, 1998) and depreciation rates for essential equipments and consumables increasing from 25% to 40%, giving tax saving incentive to the healthcare institutions,

3) introduction of Medical Visa and Medical Attendant Visa for a period of one year with four multiple entries in 2005 and allowing 100% FDI in Healthcare sector in 2000,

4) making long term loans and capital cheaper for Healthcare institutions due to 2002-2003 and 2003-2004 union budget and introduction of 100% Income Tax exemption for a period of five years, for new hospitals with more than 100 beds and located outside eight agglomerations (Finance Act, 2008, GOI), etc.

As a result of these policies and due to existence of huge demand for the health service sector, this sector provides incentive to the investors for investments from domestic as well as financial investors and private equity firms. Funds such as ICICI Ventures, IFC, Ashmore and Apax Partners invested about US$ 450 million in the first six months of 2008-2009 compared to US$ 125 million during the same period of the previous year. Feedback Ventures expects private equity funds to invest at least US$ 1 billion during 2009-2013. 12 percent of the US$ 77 million venture capital investments in July-September 2009 were in the healthcare sector. GE plans to invest over US$ 3 billion on R&D, US$ 2 billion to drive healthcare information technology and health in rural and underserved areas, US$ 1 billion in partnerships, content and services, over the next six years. International clinic chain Asklepios International plans to invest US$ 100 -200 million in the Indian healthcare market. Gulf-based group Dr Moopen is planning to invest US$

200 million for setting up hospitals and eye-care centres across India. Fortis is planning to invest US$ 55 million to expand its pan-India operations.

In the recent decade the medical devices and equipments industry has been successful attracting foreign direct investment too though this sector is importing 50%-60% till now. From merely US$2.3 million in 2000 it reached US$ 147.69 million in 2009. Some of big foreign firms in the sector invested in India either directly or through collaborations and joint ventures. Some to mention are GE (USA), Isoft (Australia), Proton Healthcare (USA) and Seimens (Germany) etc.

The term international fragmentation has been used widely in trade literature, the notable contributors are Jones & Kierzkowski (2003), Deardoff (2001), Jones and Marjit (2001), Marjit (2007), Marjit (2009) etc. All the authors mentioned above have discussed either the causes behind the term international fragmentation or relate it (fragmentation) with the pattern of trade. Maiti and Marjit (2007) have considered a partial equilibrium framework and they have shown that international trade enhances the possibilities of fragmentation in the production process in Indian context. Jones and Marjit (2008) have considered a general equilibrium framework and from which we can argue that trade may lead to more fragmented activities relative to autarky even if one observes specialization. Again Marjit, Beladi and Chakraborty (2003) have shown that reduction in the price of intermediate product may lead to a zone which is more fragmented. They have also examined the impact of fragmentation on skilled-unskilled wage gap.

Though there exists a quite few number of theoretical works related to international fragmentation but very few of them have used general equilibrium structure. Unfortunately at the theoretical level almost no work in a general equilibrium structure has been done to relate international fragmentation with health sector. The present paper attempts to fill up the lacuna in this line.

The present paper is an extension of Marjit, Beladi and Chakraborty (2003) as in this model both an exportable sector a health service sector and a health intermediate sector have been introduced. The present paper attempts to examine not only the reasons behind international fragmentation but also the impact of such international fragmentation on the output levels of

health sector. The impact of FDI to health sector in the presence of international fragmentation is also our concerning fact.

In this paper we have tried to examine, i) the impact of movement towards international fragmentation of the health sector in the absence of trade liberalization and ii) impact of trade liberalization on the health service sector in the presence of international fragmentation. To do so we have considered two different models. In model 1 we have shown the impact of movement towards international fragmentation of the health sector in the absence of trade liberalization. As the economies liberalize, competition in all the markets should increase. To capture the impact of such liberalization on the output level of the health service sector in the presence of international fragmentation we have considered model 2.

The paper is organized in the following manner. Section 2 considers model 1. It has one subsection. Subsection 2.1 considers the drive towards fragmentation and health sector. Section 3 considers model 2. It is divided into three subsections. Sub section 3.1 considers FDI in the health sector, Subsection 3.2 considers international health capital immobility and subsection 3.3 considers international health capital mobility. Finally, the concluding remarks are made in section 4.

2. Model 1

We consider a small open economy consisting of four sectors in a Heckscher-Ohlin-Samuelson framework. Out of the four sectors, one is an agricultural sector(A), which produces an exportable good (X_A) using unskilled labour(L) and capital(K). The second sector is a manufacturing sector(M), which produces importable good (X_M) by using skilled labour (S) and capital. K is perfectly mobile between sectors A and M. The third and fourth sectors of our economy are the domestic intermediate health good producing sector (I) and the health sector (H) respectively. Sector I uses skilled labour along with health capital (N) for production of the intermediate health product (X_I) of our economy and the health sector uses health capital[4],

[4] By the term health intermediate goods we actually mean those commodities which are exhausted due to the course of production in the health service sector(H), e.g. injectable goods and its associated products, several chemicals,

skilled labour and intermediate health input (X_I) to produce another exportable product (X_H). Here we assume that the requirement of intermediate goods for the production of one unit of output of the health sector is fixed. Unskilled labour (L) has been considered as specific to the agricultural sector (A). Skilled labour is perfectly mobile among sectors M, H and I. The skilled wage rate in the health sector is assumed to be fixed at a higher level compared to the skilled wage rate prevail in rest of the sectors. Here health capital is perfectly mobile between sectors I and H. Health capital consists of both domestic health capital (N_D) and foreign health capital(N_F), and additionally we assume N_D and N_F are perfect substitutes. This implies an increase in foreign health capital will lead to an increase in the overall health capital endowment of the economy.

The agricultural product is considered as the numeraire its price is set equal to unity. We assume that both foreign capital income and foreign health capital income are fully repatriated. Markets are competitive. Production function in each sector exhibit constant returns to scale with diminishing marginal productivity to each factor. The following notations are used in this model.

X_i = product produced by the ith sector, i = A, M, I, H

P^*_A = world price of commodity A

P_A = domestic price of commodity A, we assume $P_A = P^*_A = 1$

P_M = world price of good M

P_I = domestically determined price of good I

P^*_I = price of the foreign intermediate commodity

P_H = world price of good H

L = fixed number of unskilled workers in the economy

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equipments used in pathology and different forms of medicines. Again by health capital we mean those equipments and products which are not exhausted due to the production process, e.g. ECG machine, X-ray machine etc.

S = stock of skilled labour

N_D = domestic health capital stock of the economy

N_F = foreign health capital stock of the economy

N = economy's aggregate health capital stock ($N = N_D + N_F$)

K = economy's aggregate capital stock

a_{ji} = quantity of the jth factor for producing one unit of output in the ith sector, j=L,S,K,N and i=A,M,I,H

θ_{ji} = distributive share of the jth input in the ith sector

λ_{ji} = proportion of the jth factor used in the production of the ith sector

W = competitive unskilled wage rate

W_S = skilled wage rate

r = rate of return to capital

R = rate of return to health capital

σ_i = elasticity of factor substitution in sector i, i = A, M, I, H.

^ = proportional change

The equational structure of the model is as follows.

The competitive equilibrium conditions in the product market for the four sectors give us the following equations.

$$a_{LA}W + a_{KA}r = 1 \quad (1)$$

$$a_{SM}W_S + a_{KM}r = P_M \quad (2)$$

$a_{SI}W_S + a_{NI}R = P_I$ (3)

$a_{SH}\,\bar{W}_S + a_{NH}R + a_{IH}\,P_I = P_H$ (4)

For simplicity we assume that a_{SH} and a_{IH} are given to us.

Equilibrium condition for the health intermediate sector is given by

$a_{IH}\,X_H = X_I$ (5)

Sector specificity of unskilled labour is given by the following equation

$a_{LA}X_A = L$ (6)

Perfect mobility of capital between sectors A and M can be expressed as

$a_{KA}X_A + a_{KM}X_M = K_D + K_F = K$ (7)

Full employment of skilled labour implies the following equation

$a_{SM}X_M + a_{SI}X_I + a_{SH}X_H = S$ (8)

Perfect mobility of health capital between sectors H and I can be expressed as

$a_{NH}X_H + a_{NI}X_I = N_D + N_F = N$ (9)

The working of the model is as follows. In this model we have nine equations with nine endogenous variables, namely W, W_S, r, R, P_I, X_A, X_M, X_I, X_H, that is, the system is solvable. From equation (1) we can express W as a function of r. Similarly from equation (2) we can express W_S in terms of r. From equation (4) we find that R is a function of P_I. Using this fact in equation (3) we can express W_S in terms of P_I. Hence from equations (1) and (2) we can express W and r as a function of P_I only. In this model we cannot determine factor prices independently from the competitive equilibrium conditions. Thus the structure is an indecomposable structure[5]. Using equations (6), (7), (8) and (9) we can express X_A, X_M, X_I and X_H as a function of P_I. Thus

[5] If the factor prices are determined independently of factor endowments we refer to the structure as a decomposable structure.

from equation (5) we can determine the value of P_I, as X_H and X_I are function of P_I. Once P_I is known W, W_S, r, R, X_A, X_M, X_I, X_H are also known.

In this section we want to analyze several causes due to which fragmentation is possible. In this model initially we have considered sector I as a domestic intermediate good producing sector. This intermediate good can be imported by the health sector from foreign but in this case it has to incur a fixed cost (F) mainly due to transaction or communication factors[6]. This is the main constraint in front of the health sector to buy foreign intermediate good and this leads to an increase in demand for domestic intermediate goods. Given supply, an increase in demand for I leads to an increase in P_I. It implies that no fragmentation situation is associated with higher level of P_I. Here we are starting with a situation where, domestic intermediate product price is greater than international intermediate product price, i.e, $P_I > P^*_I$. From equation (4) we can say that a fall in P_I leads to an increase in R, since P_H and W_S are exogenously given[7]. Let R^* be the rate of return on health capital corresponding to the price of the intermediate good P^*_I. It is to be noted that P^*_I and R^* are also negatively related by the similar argument as we use in case of P_I with R. Let R^0 be the initial equilibrium level of R. Then we can say $(R^* - R^0)$ varies inversely also with P_I^*. This is because R^* changes due to a change in P_I^*, for given R^0. So we can say that the health sector uses domestic intermediate good, that is, fragmentation is not preferable, iff $(R^* - R^0) N < F$.

Using the similar argument we can consider different cases, that is,
case 1: fragmentation is preferable iff $(R^* - R^0) > F/N$
case2: fragmentation is not preferable iff $(R^* - R^0) < F/N$;
case 3: health sector will be indifferent iff $(R^* - R^0) = F/N$.
The above analysis can be explained with the help of figure-1.

[Figure 1 here]

In this paper we find that there exists two critical values of P_I^* such that for all $P_I^* \in [\bar{P}_I^*, P_I^{*max}]$ there is no fragmentation, where $\bar{P}_I^*$ is the lower critical value of P_I^* and P_I^{*max} is the upper

[6] For details see Marjit, Beladi and Chakraborty (2003).
[7] For details see Appendix A.

critical value of P_I^*. Here P_I^{*max} is nothing but the domestic market determined value of P_I. It is to be noted for $P_I^* \in (0, \bar{P}_I^*)$ there will be fragmentation. Thus it is clear from the above figure that $\bar{P}_I^*$ is the lower critical value of P_I^* and it is the maximum price of the foreign intermediate for which health sector will go for fragmentation. In this figure the area left of $\bar{P}_I^*$, that is, where $\bar{P}_I^* > P_I^*$ we have a situation of fragmentation whereas the area to the right of $\bar{P}_I^*$ upto P_I^{*max} gives us a situation where fragmentation is not possible. For simplicity here we consider $P_I^* \in [\bar{P}_I^*, P_I^{*max}]$ as the relevant interval for P_I^*.

From case 2 we can infer that fragmentation may be possible due to either fall in F or an increase in N (or N_F hereafter). It is to be noted that a fall in F or an increase in N_F leads to a downward shift of the F/N schedule. It implies an expansion of the area to the left of $\bar{P}_I^*$ and contraction of the area of its counterpart. Again for given F and N, fall in P_I towards the lower limit of P_I^* ($\bar{P}_I^*$) leads to a situation where the possibility of fragmentation increases. We state the results in the form of following proposition.

Proposition 1: *Fall in the price of domestic intermediate, reduction in fixed cost or an inflow of foreign health capital enhances the possibility of fragmentation.*

2.1 The Drive towards Fragmentation and the Health Sector

So far we have analyzed the causes and possibilities of fragmentation. In this section we are trying to focus on the drive towards fragmentation in the presence of health sector. It is captured through a fall in domestic price (P_I) of the intermediate product[8]. We have already mentioned that fall in P_I towards $\bar{P}_I^*$ implies a shift from a regime of no fragmentation to a regime of fragmentation[9]. Here we have to examine the intermediary effects of such a regime change.

From equation (4) we can argue that a fall in P_I leading to an increase in R, as P_H and W_S are given. From equation (3) we can say that a reduction in P_I and an increase in R lead to a situation

[8] Here we assume that fragmentation is possible only through reduction P_I because the change of F and N are significantly low in the regime where trade liberalization is absent.
[9] Here we consider a finite change of P_I.

where to maintain equality W_S must have to fall. Again reduction in W_S leads to an increase in r, as P_M is given in equation (2). Using this fact in equation (1) we get a fall in W. This fall in W implies an increase in a_{LA} so that for maintaining unskilled labour market equilibrium condition X_A must go down. Again fall in P_I leads to an increase in r and hence a_{KA}, a_{KM} must go down. Thus from equation (7) we can get an increase in X_M. Using equation (5) in equation (9) we obtain

$$(a_{NH} + a_{NI}\, a_{IH})\, X_H = N \qquad (9^{/})$$

From equation ($9^{/}$) we can easily argue that X_H must go up due to fall in P_I [as a_{NH} and a_{NI} decrease due to an increase in R]. Similarly equation (8) can be written as

$$a_{SI}\, X_I = (S - a_{SH}\, X_H - a_{SM}\, X_M) \qquad (8^{/})$$

Fall in P_I leads to a fall in W_S. Reduction in W_S leads to increase in the levels of both a_{SM} and a_{SI}. Thus increase in the levels of $a_{SH}\, X_H$, $a_{SM}\, X_M$ and a_{SI} lead to reduction of the right hand side and expansion of left hand side of equation ($8^{/}$). Hence for maintaining skilled labour market equilibrium condition X_I must go down[10]. Thus the following proposition can now be established.

Proposition 2: *A movement from a regime of no fragmentation towards a regime of fragmentation leads to an increase in the levels output of both health and manufacturing sector and a reduction in the level of output of the agricultural sector.*

3. Model 2

3.1 FDI in the Health Sector

In the earlier model we have analyzed the impact of movement from no fragmentation regime to a regime of fragmentation on the output levels of health sector. In this model we are trying to

[10] Here we have implicitly assumed that the supply of intermediate health product is the sum of X_I and X_I^+, where X_I^+ is the amount of import of intermediate health product. Thus actual equilibrium condition for health intermediate market is $a_{IH}\, X_H = X_I + X_I^+$. But in the absence of fragmentation it implies $X_I^+ = 0$. That is why we have considered equation (5) initially. It is to be noted that as we move towards international fragmentation we get an increase in X_H and reduction of X_I. Thus for maintaining the the above equality X_I^+ must go up as an adjustment term.

analyze the impact of liberalization on the health sector in the presence of fragmentation in the new set up. In this model we have assumed that the skilled worker of the health service sector is also earning competitive skilled wage[11]. In this paper we consider that total foreign health capital stock consists of both domestic health capital and foreign health capital. We have considered two regimes here. One is the regime of international health capital immobility and the second one is the regime of international health capital mobility. In the context of first regime we have considered foreign health capital as exogenous implying the existence of foreign health capital immobility. In the second regime we have considered foreign health capital as endogenous.

3.2 International Health Capital Immobility

We consider a small open economy where international health capital is immobile[12] and it consists of four sectors in a Heckscher-Ohlin-Samuelson framework. The modified equational structure can be written as

The competitive equilibrium conditions in the product market for the three sectors give us the following equations.

$$a_{LA}W + a_{KA}r = 1 \quad (1)$$

$$a_{SM}W_S + a_{KM}r = P_M \quad (2)$$

$$a_{SH}\, W_S + a_{NH}R + a_{IH}\, \bar{P}_I^* = P_H \quad (3)$$

For simplicity we assume that a_{SH} and a_{IH} are given to us.

Equilibrium condition for the intermediate health product is

$$a_{IH}\, X_H = X_I^+ \quad (4)$$

[11] Here we also assume that a_{SH} is a fixed input-output coefficient as we assume in model 1.

[12] International health capital immobility is a situation where domestic rate of return on foreign health capital (R) is greater than the rate of return on foreign health capital in the international market (R^+) and there is restriction on the entry of foreign health capital to the domestic economy.

Here X_I^+ is the amount of import of intermediate products.

Sector specificity of unskilled labour is given by the following equation

$$a_{LA}X_A = L \quad (5)$$

Perfect mobility of capital between sectors A and M can be expressed as

$$a_{KA}X_A + a_{KM}X_M = K_D + K_F = K \quad (6)$$

Full employment of skilled labour implies the following equation

$$a_{SM}X_M + a_{SH}X_H = S \quad (7)$$

Sector specificity of foreign health capital is given by the following equation

$$a_{NH}X_H = N_D + N_F = N \quad (8)$$

In this model we have eight equations with eight unknowns, namely W, W_S, r, R, X_A, X_M, X_I^+, X_H, that is, the system is solvable. From equations (1), (2) and (3) we can express W, W_S and R as a function of r. In this model we cannot determine factor prices independently from the competitive equilibrium conditions. Thus the structure is an indecomposable structure. Using (5) and (6) we can express X_A, X_M in terms of r. Thus from equation (7) we can express X_H as a function of r. Again from equation (8) one can express X_H in terms of r, as N is given. Hence by using equations (7) and (8) we can determine the values of X_H and r. Once r is known W, W_S, R, X_A, X_M, X_I^+ are also known.

3.3 International Health Capital Mobility

Here we assume that in the presence of international health capital immobility we have $R > R^+$, where R^+ is the given return on foreign health capital in the international market. In such a situation we have no foreign health capital inflow. If R falls to $\tilde{R}$, where, $R > \tilde{R} > R^+$, we find that

there is some amount of inflow of foreign health capital (N_F) and at last we will reach at the equilibrium level[13] of N_F where, $R = R^+$.

Here, we assume that N_D is exogenous whereas N_F is assumed to be an endogenous variable and we use $R = R^+$ in model 2. Thus here we also have eight independent equations with eight endogenous variables, so the system can be solved. Using $R= R^+$ from equations (2) and (3) we can solve for W_S and r (as $P_I = \bar{P}_I^*$). Once W_S and R are known a_{NH} is also known. Thus from equation (8) we can express X_H as a function of N_F, as R is already known and W_S can be explained in terms of R. Using equations (5) and (6) we can determine the values of X_A and X_M. Hence from equation (7) we can derive the value of X_H. Once X_H is known then N_F and X_I^+ can also be determined from equation (8) and (4) respectively and this completes the working of the model.

Explanations of sectoral effects due to liberalization are given below. An increase in N_F implies a fall in R. From equation (3) we can say that a fall in R leads to an increase in W_S. From equations (1) and (2) we can argue that an increase in W_S implies an increase in W and a reduction in r[14]. Since an increase in W implies a reduction in a_{LA}, for maintaining unskilled labour market equilibrium condition X_A must go up. Again fall in r leads to an increase in a_{KA} and a_{KM}. Thus from equation (6) we can get a reduction in the output level of sector M (X_M). Fall in R due to an inflow in N_F leads to an increase in W_S. Increase in W_S leads to a fall in a_{SM}. Thus a fall in a_{SM} X_M leads to an increase in ($S - a_{SM} X_M$), that is, availability of skilled labour increases to the health sector and it induces the health sector to expand[15]. From equation (5) we can argue that X_I^+ must go up as X_H increases due to international health capital mobility.

Proposition 3: *A shift from a regime of international health capital immobility to health capital mobility causes an increase in the levels output of both health and agricultural sector and a reduction in the level of output of the manufacturing sector.*

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[13] At $R=R^+$, we have the equilibrium level of foreign health capital inflow due to equilibrium in the international health capital market.

[14] See Appendix B.

[15] As a_{SH} is given, from equation (7) we can show that an increase in ($S- a_{SM}X_M$) must increase in X_H, otherwise skilled labour market will be in disequilibrium.

4. Concluding Remarks

Health service sector and health intermediate sector (medical devices and equipments sector) are gaining more importance among the economists and hence these sectors become most important parts of the social sector of any developing economy like India. The present paper has considered two different models. In the first model we build up a structure (based on H-O-S general equilibrium structure) where we introduce health service sector as an export sector and more interestingly we assume that the production function of that sector can be fragmented. Here we also assume that the wage of skilled labour in the health service sector is fixed at a higher level compared to the competitive skilled wage rate. The above mentioned sectors use a special type of capital (health capital). In such a set up we have shown that an increase in foreign health capital or a decrease in price of health intermediate product may increase the possibilities of fragmentation. Apart from this, from that model we have also shown that a change of regime from no fragmentation towards fragmentation leads to an increase in the levels output of both health and manufacturing sector and a reduction in the level of output of the agricultural sector.

In the second model we have considered a three sector general equilibrium structure where the third sector is a health service sector and the production process of that sector is fragmented. Here we have examined the impact of trade liberalization in the form of regime change on the output levels of different sectors, in the presence of fragmentation. In this part we have shown that a change in regime from international health capital immobility to international health capital mobility, leads to expansion of both health sector and agricultural sector and contraction of manufacturing sector.

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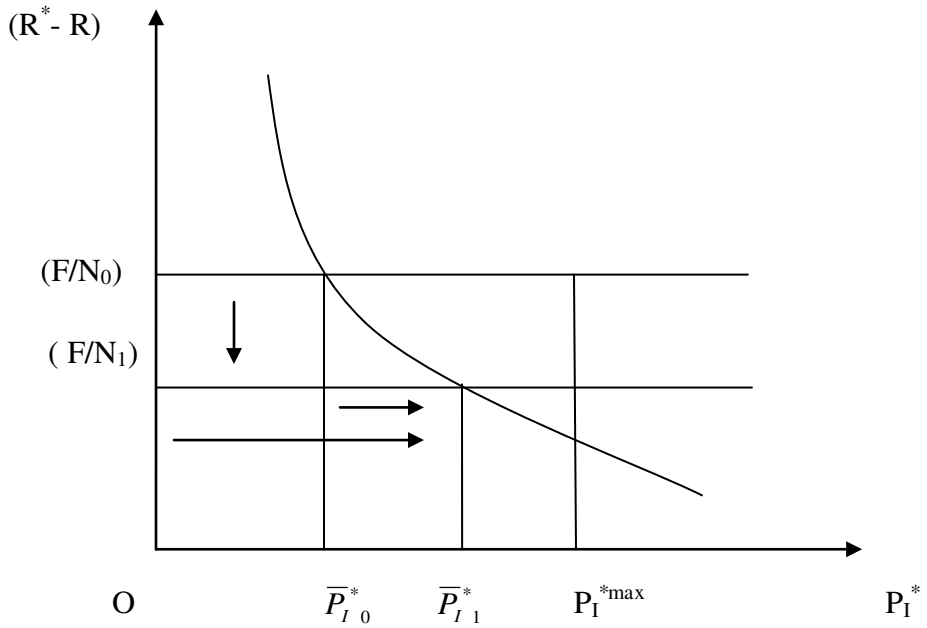

[Figure 1]

Appendices

Appendix A

Differentiation of equation (4) gives us

$$\theta_{NH}\ \hat{R} + \theta_{NH}\ \hat{a}_{NH} + \theta_{IH}\ \hat{P}_I = 0$$

Now $\sigma_H = (\hat{a}_{NH} - \hat{a}_{IH} / \hat{P}_I - \hat{R})$

$$\hat{a}_{NH} = (\hat{P}_I - \hat{R})\sigma_H$$

Using it we get

$$\theta_{NH}(1- \sigma_H)\ \hat{R} + (\theta_{NH}\sigma_H + \theta_{IH})\ \hat{P}_I = 0$$

$$\hat{R} = - (A_2/A_1)\ \hat{P}_I \qquad \text{(A.1)}$$

Where, A_1, $A_2 > 0$.

Differentiation of equation (3) gives us,

$$a_{SI}\, dW_S + W_S\, da_{SI} + a_{NI}\, dR + R\, da_{NI} = dP_I$$

From the envelop condition we get

$$W_S\, da_{SI} + R\, da_{NI} = 0$$

Using envelop condition we get

$$\theta_{SI}\ \hat{W}_S + \theta_{NI}\ \hat{R} = \hat{P}_I$$

Using (A.1) we get

$$\hat{W}_S = \{(1/\theta_{SI}) + (\theta_{NI}/\theta_{SI})(A_2/A_1)\}\ \hat{P}_I$$

$$\hat{W}_S = A_3\ \hat{P}_I \qquad \text{(A.2)}$$

Where, $A_3 > 0$.

Differentiating equation (2) we get

$$\hat{r} = - (\theta_{SM}/\theta_{KM})\hat{W}_S \qquad \text{(A.3)}$$

Similarly from equation (1) one obtain

$$\hat{W} = -(\theta_{KA}/\theta_{LA})\,\hat{r} \qquad \text{(A.4)}$$

Differentiation of (7) gives us

$$\hat{X}_H = (1/\lambda_{IH})\,\hat{X}_I \qquad \text{(A.5)}$$

Differentiating equation (6) we get

$$\lambda_{NH}\ \hat{X}_H + \lambda_{NH}\ \hat{a}_{NH} + \lambda_{NI}\ \hat{X}_I + \lambda_{NI}\ \hat{a}_{NI} = 0 \qquad \text{(6.A)}$$

We know, $\sigma_I = (\hat{a}_{NI} - \hat{a}_{SI}/\ \hat{W}_S - \hat{R})$ (A.6)

Again $W_S\ da_{SI} + R\ da_{NI} = 0$

$$\hat{a}_{SI} = -(\theta_{NI}/\theta_{SI})\,\hat{a}_{NI} \qquad \text{(A.7)}$$

Using (A.7) in (A.6) we get

$$\hat{a}_{NI} = \sigma_I\ \theta_{SI}\,(\hat{W}_S - \hat{R}) \qquad \text{(A.8)}$$

Inserting the value of (A.8) in equation (6.A) and simplifying we get

$$(\lambda_{NH} + \lambda_{NI}\ \lambda_{IH})\ \hat{X}_H = (-\lambda_{NH}\,\sigma_H)\ \hat{P}_I + (-\lambda_{NI}\ \theta_{SI}\,\sigma_I A_3)\ \hat{P}_I + (\lambda_{NH}\,\sigma_H + \lambda_{NI}\ \theta_{SI}\,\sigma_I)(-A_2/A_1)\ \hat{P}_I$$

$$\hat{X}_H = (A_5 + A_6 + A_7/A_4)\ \hat{P}_I \qquad \text{(A.9)}$$

Where, $A_5, A_6, A_7 < 0$ and $A_4 > 0$.

Differentiation of equation (6) gives us

$$\lambda_{LA}\ \hat{a}_{LA} + \lambda_{LA}\ \hat{X}_A = 0 \qquad \text{(6.A)}$$

We know, $\sigma_A = (\hat{a}_{KA} - \hat{a}_{LA}/\hat{W} - \hat{r})$

$$\hat{a}_{LA} = \hat{a}_{KA} - \sigma_A(\hat{W} - \hat{r}) \qquad \text{(A.10)}$$

Using envelop condition we get

$$\hat{a}_{KA} = -(\theta_{LA}/\theta_{KA})\,\hat{a}_{LA} \qquad \text{(A.11)}$$

Using (A.11) in equation (A.10) and simplifying we get

$$\hat{a}_{LA} = -\sigma_A\,(\theta_{KA}\ \theta_{SM}/\theta_{KM}\ \theta_{LA})\ A_3\ \hat{P}_I \qquad \text{(A.12)}$$

Using (A.12) in (6.A) we can get

$$\hat{X}_A = \sigma_A \, (\theta_{KA} \, \theta_{SM} / \theta_{KM} \, \theta_{LA}) \, A_3 \, \hat{P}_I \qquad (A.13)$$

Differentiation of equation (7) gives us

$$\lambda_{KM} \, \hat{X}_M = \lambda_{KA} \, \hat{a}_{KA} - \lambda_{KM} \, \hat{a}_{KM} - \lambda_{KA} \, \hat{X}_A$$

Using (A.11) and (A.12) we get

$$\hat{a}_{KA} = A_8 \, \hat{P}_I \qquad (A.14)$$

Where, $A_8 = \sigma_A \, (\theta_{KA} \, \theta_{SM} / \theta_{KM} \, \theta_{LA}) \, A_3 \, (\theta_{LA} / \theta_{KA}) > 0$.

Using the elasticity of substitution of sector M and envelop condition we can get

$$\hat{a}_{KM} = \sigma_M \, (\theta_{SM} / \theta_{KM}) \, A_3 \, \hat{P}_I \qquad (A.15)$$

Inserting the values of (A.13), (A.14) and (A.15) one can obtain

$$\hat{X}_M = [\{ \lambda_{KA} \, A_8 - \lambda_{KM} \, \sigma_M \, (\theta_{SM} / \theta_{KM}) \, A_3 - \lambda_{KA} \sigma_A \, (\theta_{KA} \, \theta_{SM} / \theta_{KM} \, \theta_{LA}) \, A_3 \} / \lambda_{KM}] \, \hat{P}_I \qquad (A.16)$$

Appendix B

Differentiating equation (3) and using envelop condition we get

$$\theta_{SH} \, \hat{W}_S + \theta_{NH} \, \hat{R} = 0$$

$$\hat{W}_S = - \left(\frac{\theta_{NH}}{\theta_{SH}}\right) \hat{R} \qquad (1.B)$$

Differentiating equation (2) we get

$$\hat{r} = - \, (\theta_{SM} / \theta_{KM}) \, \hat{W}_S \qquad (B.1)$$

Using (1.B) in equation (B.1) we get

$$\hat{r} = (\theta_{SM} \, \theta_{NH} / \theta_{KM} \, \theta_{SH}) \, \hat{R}$$

$$\hat{r} = B_1 \, \hat{R} \qquad (2.B)$$

Where, $B_1 > 0$.

From equation (1) after differentiation one obtain

$$\hat{W} = -(\theta_{KA}/\theta_{LA})\,\hat{r} \qquad \text{(B.2)}$$

Using (2.B) in equation (B.2) we can obtain

$$\hat{W} = -(\theta_{KA}/\theta_{LA})\,B_1\,\hat{R} \qquad \text{(3.B)}$$